

# The Effects of Different Anions and pH on the Corrosion Protection Properties of Polyaniline Deposited on Iron Electrodes

Anna M. Fenelon and Carmel B. Breslin

Department of Chemistry,  
National University of Ireland Maynooth,  
Maynooth, Co. Kildare,  
Ireland

In recent years there has been a great interest in both the electrochemical and corrosion protection properties of conducting polymers, such as polyaniline deposited on iron and steel<sup>1-3</sup>. The electropolymerization of aniline, generating polyaniline, (PANI) on inert metals such as platinum is well documented<sup>4</sup>. However, the electropolymerization of aniline on iron is more difficult since iron is an active metal and so the dissolution of the metal in the acidic environment, in which most electropolymerization reactions occur, becomes a problem. This difficulty can be overcome by using oxalic acid to perform the electropolymerization, as this electrolyte forms an oxalate layer over the iron electrode, protecting the metal and allowing the polymerization reactions to occur<sup>5</sup>. Polyaniline undergoes redox reactions, from a fully reduced state to a fully oxidized state changing the properties of the film from an insulating to a conducting film. Hence, the surrounding environment can have a significant effect on the coating as doping of the film can occur by the counter ions following electropolymerization or throughout the electropolymerization process<sup>6</sup>.

In this paper the effects of solution pH and the nature of the solution ions on the corrosion protection properties of PANI deposited on iron electrodes are shown and discussed. The polyaniline films were formed by cyclic voltammetry in 0.1 M oxalic acid solutions containing 0.1 M distilled aniline at a scan rate of 10 mV/s. The electrochemical and corrosion protection properties of the coated electrode were then studied in a range of electrolytes including borate, acetate, nitrate and EDTA containing-chloride solutions. The pH of these electrolytes was altered from an acidic pH of 3.0 to an alkaline pH of 10.4 using HCl and NaOH respectively.

The coated electrodes were immersed in the solutions for a range of time intervals from 120 to 960 mins and then the electroactivity and corrosion protection properties of the PANI coatings were evaluated. A typical example of a potentiodynamic plot, recorded for pure iron and PANI-coated iron in alkaline EDTA-containing chloride solutions, is shown in Figure 1. Dissolution of pure iron is observed at potentials below 0 V(SCE), which is enhanced by the presence of the complexing EDTA species. However, the breakdown potential is increased to values in excess of 0.5 V(SCE) for the PANI-deposited iron substrate showing that the PANI layer protects the underlying iron substrate. It was found that the electrochemistry of the PANI coating and its corrosion protection properties were dependent on the nature of the solution species and on the pH of the aggressive solution.

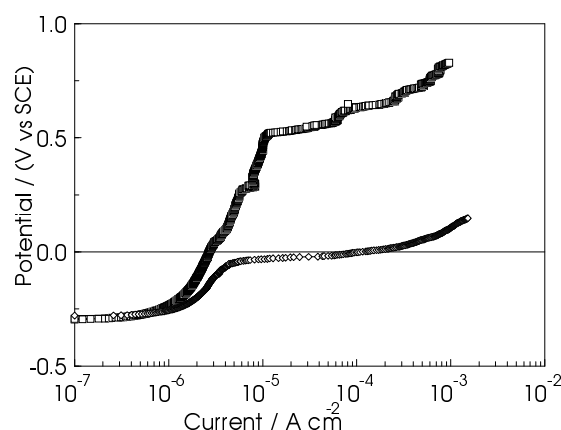


Figure 1: Potentiodynamic pitting scans of  $\diamond$  pure Fe and  $\diamond$  PANI-coated Fe in a 0.05 M EDTA, 0.015 M NaCl solution, pH 10.4

## REFERENCES

1. D.Sazou and C.Georgolis, *J. Electroanal. Chem.*, **429** (1997) 8.
2. M.C. Bernard, A. Hugot-LeGoff, S. Joiret, N.N. Dinh and N.N. Toan, *J. Electrochem. Soc.*, **146** (1999) 995.
3. P. Li, T.C. Tan, J.Y. Lee, *Synthetic Metals*, **88** (1997) 237.
4. B.J. Johnson, S.M. Park, *J. Electrochem. Soc.*, **143** (4), (1996), 1269.
5. J.L. Camalet, J.C. Lacroix, S. Aeiyaeh, K. Chane-Ching, P.C. Lacaze, *J. Electroanal. Chem.* **416** (1996) 179.
6. A.J. Motheo, J.R. Santos Jr, E.C. Venancio and L.H.C. Mattoso, *Polymer*, **39** (26), (1998), 6977.

## Acknowledgements

The authors would like to acknowledge the support of this work by Enterprise Ireland.